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DESTROYER ENGINEERED OPERATING CYCLE (DDEOC)

System Maintenance Analysis

FF-1052 CLASS

BASIC POINT DEFENSE SURFACE MISSILE LAUNCHING SYSTEM

SMA 204-7212

REVIEW OF EXPERIENCE

October 1976

Prepared for
Director, Escort and Cruiser
Ship Logistic Division
Naval Sea Systems Command
Washington, D. C.
under Contract N00024-76-C-4319

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This report is the Review of Experience for the FF-1052 Class Basic Point Defense Surface Missle Launching System.

DESTROYER ENGINEERED OPERATING CYCLE
(DDEOC)

SYSTEM MAINTENANCE ANALYSIS
FF-1052 CLASS
BASIC POINT DEFENSE SURFACE MISSILE LAUNCHING SYSTEM

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ARINC Research Corporation
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FOREWORD

This report is the Review of Experience for the FF-1052 Class Basic Point Defense Surface Missile Launching System. It presents a review of the maintenance experience for the system, an analysis of the problems encountered, and recommendations for corrective action. The recommendations are directed toward achieving for this system the DDEOC goals of (1) improved material condition at an acceptable cost, and (2) operational availability equal to or better than the present level during an extended operating cycle.

SUMMARY

1. INTRODUCTION

The Destroyer Engineered Operating Cycle (DDEOC) Program goal is to effect an early improvement in the material condition of shipboard systems, at an acceptable cost, while maintaining or increasing their operational availability during an extended operating cycle. In support of this program goal, System Maintenance Analyses (SMAs) are being conducted for selected systems and subsystems of FF-1052 Class ships. System Maintenance Analyses consist of several elements, the first of which is a Review of Experience (ROE). This report documents the ROE for the FF-1052 Class Basic Point Defense Surface Missile Launching System.

2. PURPOSE OF THE REVIEW OF EXPERIENCE

An ROE is an analysis of existing and potential problems that affect the operational performance and maintenance of a system. The report which documents an ROE serves as a vehicle for assessment of the significance and consequences of identified problems and recommendations for specific actions to support an extended (54-month) operating cycle. Implementation of the actions recommended herein should result in the achievement of the DDEOC Program goal for the Launching System.

3. CONCLUSIONS

Several components of the Launching System are exhibiting a significant maintenance burden; however, with adequate planning and support, the Launching System can satisfactorily meet the requirements of DDEOC. The identified problem areas, recommended corrective actions, and presently planned Ordnance Alterations (ORDALTs) appear compatible with DDEOC Program requirements.

Each scheduled ORDALT can be completed within a 3-week time period. Further, all currently authorized ORDALTs, with one exception, can be accomplished prior to Baseline Overhaul. A planned change to the Fire

Control System, scheduled for accomplishment in FY 78 or FY 79, will necessitate subsequent modifications to the Launching System. That ORDALT will also require less than 3 weeks for accomplishment, and can be completed during a routine dockside period if planned for in advance.

The heaviest operational maintenance burden identified for the Launching System is caused by corrosion. This burden can be alleviated through increased emphasis on scheduled maintenance directed toward corrosion control.

The earliest predicted need for Class A overhaul is during the Regular Overhaul (ROH) immediately following the first EOC. Considerable planning will be required to accomplish Launching System turnaround during the first ROH and during the second cycle of FF-1052 Class ships. Material Condition Standards should be developed to provide an early indication of need for Launching System overhaul on individual ships of the Class. Table S-1 summarizes the specific problem areas and corresponding recommendations resulting from this analysis.

Table S-1. SUMMARY OF PROBLEMS AND RECOMMENDATIONS FOR FF-1052 LAUNCHING SYSTEM

Item	Component/Problem	Description of Problem	Recommendation
1	MK 509/Accessory Rail Adaptor Bracket	Incompatibility of Launcher rail and rail adaptor bracket, resulting in damage during installation or performance of test.	Complete installation of ORDALT 8301, a design revision to improve rail adaptor bracket, and verify effectiveness of ORDALT.
2	Launcher Guide MK 9/ Band Assy Retaining Adjusting Bolts	Galvanic corrosion	Investigate feasibility of using the same noncorrosive material for both the band and retaining adjusting bolts. If feasible, develop ORDALT to implement change in materials.
3	Loader MK 13/Personnel Safety	Instability of loading platform.	As of July 1976, ORDALT 08587, designed to improve platform stability, has been installed on all FF-1052 Launching Systems. Verify effectiveness of this ORDALT by ship survey. If ineffective, develop new ORDALT to assure a safe and stable loading platform.
4	Launching System MK 25/PMS	General corrosion, particularly in the Guide and Carriage.	Increase emphasis on corrosion control by revising PMS.
5	Launching System/POT&I and "Mini-POT&I"	Improved inspection techniques for the assessment of overall Launching System condition require development to identify corrosion severity and approaching need for Class A overhaul.	Revise POT&I to incorporate specific procedures for accurately assessing overall Launching System material condition. Develop "Mini-POT&I" for use by DDEOC teams to assess overall condition prior to SRAs.
6	Test Set MK 509/ Operational Procedures and ILS	High repair rate, long turnaround, ineffective repair.	Evaluate Test Set MK 509 operational usage and support procedures. Develop recommendations for improvement.

CONTENTS

CONTENTS (continued)

CHAPTER ONE

INTRODUCTION

1.1 PURPOSE AND SCOPE

The Review of Experience is an analysis of existing and potential problems that affect the operation and maintenance of the Basic Point Defense Surface Missile (BPDSMS) Launching System. This document assesses the significance and consequences of the problems identified, and recommends specific actions to support an extended operating cycle (EOC). Implementation of the recommended actions should aid in achieving the DDEOC Program goal for the Basic Point Defense Launching System, which is to effect an early improvement in the material condition of the system, at an acceptable cost, while maintaining or increasing the system's operational availability during the EOC.

This analysis is specifically applicable to the components included in the Basic Point Defense Surface Missile Launching System MK 25 MODs 0 and 1 and includes the Test Set MK 509 and its associated accessories. Only those components onboard FF-1052 Class ships as of the fourth quarter of FY 1976 have been considered. The Fire Control System MK 115 -- to be addressed in a future System Maintenance Analysis (SMA) -- and the Sparrow Missile are not subjects of this analysis. The system boundaries and configuration, together with a listing of system components, are presented in Appendix A.

1.2 SYSTEM FUNCTION

The Basic Point Defense Surface Missile Launching System, MK 25, serves as a ready storage facility for eight Sparrow missiles, sends pre-launch and firing signals to a selected missile, and functions as the missile launch platform.

This system and the MK 115 Fire Control System function together to detect and track a target, to fire the Sparrow missile, and to guide the missile to target intercept. They comprise the essential elements of the FF-1052 Class surface-to-air close-in defense capability.

1.3 REPORT FORMAT

Chapter Two of this report describes the approach taken in the analysis; Chapter Three presents the results, including significant observations made during the analysis and discussions of identified component/equipment problem areas. Chapter Four summarizes the overall conclusions derived from the System Maintenance Analysis and the resultant recommendations, followed by a list of references and sources of information. Three appendixes provide information supporting the analyses.

CHAPTER TWO

ANALYSIS APPROACH

The Basic Point Defense Surface Missile (BPDSMS) Launching System was analyzed by individual components, as defined in Figures A-1 and A-2 (see Appendix A). All components shown in these figures are addressed in this analysis. Basic knowledge of the Launching System was gained through a review of Allowance Parts Lists, (APLs), Ordnance Publications, Maintenance Index Pages (MIPs), Maintenance Requirement Cards (MRCs), and other relevant documentation. System configuration, function, and operation, as well as overall maintenance philosophy, were determined.

2.1 PROBLEM ANALYSIS

FF-1052 Class Maintenance Data Collection Subsystem (MDCS) data for the period 1 January 1970 through 31 December 1974 were utilized in this analysis. All the corrective maintenance data for the FF-1052 Class ships were obtained from the Maintenance Support Office (MSO) in Mechanicsburg, Pennsylvania. The MDCS data were sorted and all data reported under the appropriate BPDSMS Launching System Equipment Identification Codes (EICs) and APLs were separated and compiled. These data were reviewed, and all APLs specifically associated with the Launching System were identified. A listing of these APLs is provided in Table A-1. Since the earliest Launching System installations occurred during the first quarter of CY 1971 and the data in this study base were for a period ending 31 December 1974, actual Launching System data were available for less than a 4-year period. A list of the specific FF-1052 Class hulls having the Launching System installed, together with the installation dates, is provided in Table A-2.

Maintenance problem areas were identified by analysis of MDCS maintenance and part replacement records, Casualty Reports (CASREPTs), and Technical Manuals. Components determined to be minor contributors to the overall maintenance burden -- on the basis of a small number of ships reporting maintenance, low Ship's Force or Intermediate Maintenance Activity (IMA) man-hour burdens, or low total replacement-part costs -- were eliminated from further analysis. Each remaining component was then analyzed to identify its high-usage replacement parts and to determine the replacement pattern for those parts. Any part replaced by 10 percent or more of the applicable ships was designated a "significant part" and identified for further analysis.

Data for parts replaced on fewer than 10 percent of the applicable ships were eliminated from further analysis on the basis that such parts were insignificant contributors to the overall maintenance burden for a particular component. However, data for high-cost parts with low replacement rates were analyzed to determine the major maintenance performed on these components.

CASREPT data for a 4-year period were analyzed, with emphasis on the components exhibiting relatively high maintenance burdens, as identified by the MDCS analysis. Components identified as primary causes of failures by CASREPTs were then ranked by percent of contribution to the total number of Launching System CASREPTs.

These steps led to the identification of Launching System components experiencing maintenance problems and the repair parts that had been most frequently replaced within those equipments.

2.2 PMS EVALUATION

In addition to the analysis of specific data on parts, a review was made of the current Planned Maintenance Subsystem (PMS) requirements to correlate identified problem areas with periodic routine maintenance and to determine if additional preventive maintenance could be incorporated into PMS to rectify those problems. The application (and inclusion into PMS) of performance or material condition assessment techniques was considered as a means for predicting the need for equipment and system maintenance. All recommended changes to PMS, including deletions of requirements, addition of new requirements, or changes to current requirements, are listed in the Maintenance Requirement Card (MRC) Evaluation Tables in Appendix B. This appendix also includes a list of the Maintenance Index Pages applicable to the Launching System equipments and a copy of those MIPs on which changes are recommended.

2.3 NAVY CONTACTS

To ensure that the analytical process included all ongoing Navy efforts concerning the Launching System, cognizant Navy technical agencies were consulted. The agencies contacted included the Naval Surface Weapons Engineering Station (NSWSES), Naval Sea Command (NAVSEA) PMS 404, Naval Sea Center, Atlantic Fleet (NAVSEACENLANT), and Type Commander representatives.

Ship surveys of three operational FF-1052 Class ships were conducted to validate conclusions derived from the analysis and to identify potential system problems not in evidence from documented data.

2.4 TREND ANALYSIS

To analyze increasing maintenance requirements with respect to elapsed time since installation, eleven FF-1052 Class hulls which had received the earliest Launching System installations -- i.e., 1971-1972 -- were identified. The reported maintenance data for these ships were then sorted and normalized by quarter after Launching System installation date. This process permits the display of trends in key maintenance parameters -- such as replacement parts cost, Ship's Force man-hours, and Intermediate Maintenance Activity man-hours -- reported by individual ships as a function of time since Launching System installation (approximately 13 quarters).

2.5 ACTION TABLES

All the recommendations made in this report require action by NAVSEA to ensure implementation or accomplishment. To assist Navy personnel in this task and to summarize the actions necessary to support the Launching System throughout the 54-month operating cycle, all recommendations made in this report have been listed in a DDEOC Action Table (see Appendix C).

CHAPTER THREE

RESULTS OF ANALYSIS

This chapter presents the results of the analysis performed on the Basic Point Defense Surface Missile Launching System. Section 3.1 addresses the analysis conducted at the component level (see system block diagram, Figure A-2, Appendix A). Section 3.2 contains those portions of the analysis dealing with the Launching System as an entity, e.g., logistics support, existing improvement programs, and future developments.

3.1 COMPONENT ANALYSIS

Tables 3-1 through 3-3 summarize historical maintenance data reported on the Launching System. The data presented in these tables provide the basis for a majority of the Launching System component and parts analyses reported herein.

Table 3-1 summarizes the maintenance burden on Launching System components as disclosed by MDCS data.

Table 3-2 identifies significant parts within major components of the Launching System. As discussed in Section 2.1, such parts are those replaced on more than 10 percent of the 28 Launching System installations on FF-1052 Class ships.

Table 3-3 summarizes by component the CASREPTs reported against the Launching System and, where possible, identifies the primary parts responsible for reported failures.

3.1.1 Guide Assembly MK 9

The Guide Assembly MK 9 has experienced a relatively high level of maintenance activity, as demonstrated by Table 3-1. The Guide had 517 maintenance transactions over the data period, the highest number for any Launching System component. This part was second highest among System components in both maintenance cost ($78,000) and number of ship man-hours required for repair (approximately 700).

Table 3-3 shows that 3 of the total of 26 CASREPTs were concerned with the Guide. Parts within the Guide cited as responsible for the failures

Table 3-1. MDCS MAINTENANCE BURDEN SUMMARY, LAUNCHING SYSTEM

(28 Hulls, 58.5 Total Ship Operating Years)

Component Identification	APL/CID Number	Maintenance Transactions			Ship's Force Man-Hours			Repair Parts Cost ($)			IMA Man-Hours			Replacement Parts		
		Total	Rank	Avg* Qty/ Ship/ Op Yr	Total	Rank	Avg* Qty/ Ship/ Op Yr	Total	Rank	Avg* Cost/ Ship/ Op Yr	Total	Rank	Avg* Qty/ Ship/ Op Yr	Total	Rank	Avg* Qty/ Ship/ Op Yr
Guide MK 9	006220002 006220066	517	1	8.8	708	2	12.1	78,344	2	1,339	214	1	3.7	228	1	3.9
Carriage MK 11	006220003	423	2	7.2	1217	1	20.8	20,072	3	343	67	3	1.1	185	3	3.1
Launcher Control Panel MK 288	006220001 006220065	394	3	6.7	260	3	4.4	185,502	1	3,171	4	7	0.1	198	2	3.4
Test Set MK 509 and Accessories	006220008 006220056	249	4	4.3	139	6	2.4	Data in error**	N.A.	N.A.	0	N.A.	0	107	5	1.8
Amplifier MK 40	006220004	235	5	4.0	228	4	3.9	7,158	5	122	0	N.A.	0	145	4	2.5
Loader MK 13	006220063	132	6	2.3	109	7	1.9	14,419	4	246	72	2	1.2	35	6	0.6
Control Panel MK 65	006220006	58	7	1.0	82	8	1.4	1,920	10	33	32	4	0.5	30	7	0.5
Motor Generator MK 6	006220005	49	8	0.8	149	5	2.5	6,623	6	113	6	6	0.1	16	9	0.3
Hydraulic Pump	006220013	26	9	0.4	20	9	0.3	1,431	11	24	7	5	0.1	9	10	0.2
Tools	006220001	19	10	0.3	14	10	0.2	3,320	8	57	0	N.A.	0	17	8	0.3
Power Supply MK 143	006220007	11	11	0.2	7	11	0.1	2,077	9	36	0	N.A.	0	4	11	0.1
Handling Equipment	0-004920027	10	12	0.2	3	12	0.1	3,940	7	67	0	N.A.	0	2	12	0.0

*Average Qty./Ship/Operating Year Calculation: $\frac{\text{Total Transactions} \div \text{No. Ships}}{\text{Total Operating Years} \div \text{No. Ships}}$

**Improper billing on numerous occasions completely invalidates this maintenance total; see Section 3.1.4.1 for additional explanation.

Table 3-2. SIGNIFICANT PARTS WITHIN LAUNCHING SYSTEM COMPONENTS
(Parts reported by 10 percent or more of 28 FF-1052 Installations)

Component	Part Identification	No. of Ships Reporting	Total Replaced	Average* Repl. Rate per Ship per Op Yr	Rank (By Repl. Rate)
Test Set and Accessories MK 509	Test Set MK 509	21	84	1.4	2
	Accessories MK 509	11	12	0.2	11
Guide MK 9	Band Assembly	4	12	0.2	11
	Hydraulic Coupling	12	54	0.9	3
	Frangible Cover	6	15	0.3	10
	Thermometer**	10	40	0.7	5
	Dust Cap (Hyd. Coup.)	7	38	0.6	6
	Anti-Icing Frame	7	25	0.4	8
Carriage MK 11	Sensitive Switch	5	12	0.2	11
Launcher Control Panel MK 288	Cell Module**	14	27	0.5	7
	Tuning Drive	10	21	0.4	9
Amplifier MK 40	Tube P/N 480269PC24	17	107	1.8	1
	Tube P/N 480269PC 7	14	43	0.7	4

*Average Replacement Rate/Ship/Operating Year Calculation: $\frac{\text{Total Transactions} \div \text{No. Ships}}{\text{Total Operating Years} \div \text{No. Ships}}$

**Reported under two APLs, both applicable to the respective Launching System component.

Table 3-3. SUMMARY OF CASREPTS FOR 28 FF-1052 LAUNCHING SYSTEM INSTALLATIONS, 1 JAN 70-31 DEC 74			
Launching System Component	No. of CASREPTs	Pct. of Total	Failure Cause
Test Set MK 509	5	19	Out of calibration on two occasions; cause of failure not accurately determined on other three occasions.
Launcher Control Panel MK 288	4	15	Tuning drive failure on three occasions; one unknown part failure.
Control Panel MK 65	4	15	Defective relays cited as primary cause on three occasions, of which two occasions involved relay CR5. One cause unknown.
Carriage MK 11	4	15	Elevation brake solenoid, train brake power-off solenoid, drive motors, and unknown part failure.
Guide MK 9	3	12	Cell thermometers inoperative, fire-through latch inoperative, safe-fire switch corroded.
Motor Generator MK 6	2	8	One failure due to fresh water intrusion, other failure due to internal short.
Amplifier MK 40	1	4	Cause unknown.
Power Supply MK 143 (2 per system)	1	4	Cause unknown.
Loader MK 13	1	4	Roller assembly inoperable, normal wear.
Hydraulic Pump Assembly	1	4	Suspected as having been intentionally thrown overboard.
Total	26		

were the cell thermometer, safe/fire barrel switch, and fire-through latch. Parts most often replaced (see Table 3-2) were the band assembly, hydraulic coupling, frangible cover, cell thermometer, dust cap (hydraulic coupling), and anti-icing frame.

All three ships surveyed cited corrosion as the principal cause of maintenance. Components within the Guide which were identified by the ships as particularly susceptible to corrosion include the band assembly, hydraulic coupling (including dust cap), cell thermometer, arming access cover pin, and safe/fire barrel switch. All three ships surveyed indicated that galvanic corrosion between the band and the retaining/adjusting bolts of the band assembly is a problem, and increased lubrication had proven ineffective in preventing corrosion.

High usage of the frangible cover and the anti-icing frames is attributable to installation problems. One ship had received covers and frames that could not be installed properly due to poor manufacturing tolerances; however, MDCS data do not reflect this problem. The safe/fire barrel switch was not analyzed because this component is not included on the APL for Guide MK 9 and, therefore, the data could not be segregated. This switch, which is installed on the aft part of the Guide, was cited as the source for one CASREPT.

3.1.2 Carriage MK 11

Table 3-1 shows that Carriage MK 11 was involved in 423 maintenance actions, ranking second highest in this respect among Launching System components. The reported replacement-part cost totalled approximately $20,000 and Ship's Force maintenance was 1,217 man-hours -- double the labor expenditure for any other component. The Carriage was the subject of 4 out of 26 CASREPTs for the Launching System.

Although the parts analysis in Table 3-2 identified only the sensitive switch as a significant part within the Carriage, ship surveys revealed a situation similar to that previously discussed for the Guide Assembly -- i.e., corrosion as the primary reason for maintenance. As a result, most Carriage maintenance involves refurbishment rather than part-replacement actions. All three ships surveyed identified the sensitive switch as a maintenance problem, and reported seizing due to corrosion as the primary cause of switch failures. Other Carriage parts identified by ship surveys as susceptible to corrosion include the 120-wire connection box, waveguide mounting bracket, manual train mechanism, stand, and lower carriage.

The MDCS data presented in Table 3-1 support the conclusion that corrosion is the primary source of Carriage maintenance. For this Launching System component, maintenance transactions have been relatively high and Ship's Force man-hours extremely high, but maintenance costs have been relatively low. The average cost per transaction, based on the Table 3-1 listing, is $47 -- an indication that refurbishment, rather than part replacement, has probably been the general rule. Since data analysis indicates that corrosion is responsible for the maintenance burden of this component, the ship survey comment in the preceding paragraph is verified.

3.1.3 Launcher Control Panel MK 288

Launcher Control Panel (LCP) MK 288 had 394 maintenance transactions, the third highest number reported in the MDCS data presented in Table 3-1. The cost of repairs totalled $185,502, the highest valid cost reported for any Launching System component. This figure yields an average annual expenditure of some $3,100 per ship.

Ship surveys indicated that the most common failure item within the LCP is the cell module, and the part failure most prevalent within the cell module is the tuning drive. The MDCS data presented in Table 3-2 confirm these survey findings. The cell module was reported 27 times by 14 ships, the tuning drive 21 times by 10 ships. Ship surveys also indicated that replacement of the entire cell module is a common practice when the tuning drive fails. Therefore, it is probable that a portion of the cell module actions are the result of failure of the tuning drive.

ORDALT 07986 provides for a spare tuning drive on a ship's APL. During the time period covered by the MDCS data base (1970-1974), this ORDALT had been only partially implemented. Since many ships had not received the spare tuning drives, replacement of the entire cell module would be common practice and may account in part for the high number of cell module replacements. Replacing the entire cell module due to tuning drive failure is not cost-effective. The cost of the tuning drive is about $1,000, while the entire cell module costs approximately $4,000. Complete implementation of ORDALT 07986 on all ships, which has now been accomplished, should result in considerable cost savings and improved operational availability. As an example, if it is assumed that the tuning drive was the primary cause of failure in 20 of the 27 cell module replacements identified in Table 3-2, a cost saving of approximately $60,000 could have been realized had the tuning drive been available as a replacement part. This amount is approximately 32 percent of the entire maintenance cost for the LCP reported over the entire data period. On the basis of the historical data presented in Table 3-1, ARINC Research estimates that implementation of ORDALT 07986 will result in significant cost savings for LCP maintenance. No further corrective action is considered necessary.

3.1.4 Test Set MK 509 and Accessories

3.1.4.1 Test Set MK 509

The data in Table 3-1 indicate that Test Set MK 509 and its accessories are a major contributor to the Launching System's reported maintenance. This component -- referred to in this discussion as the Test Set -- has been involved in 249 maintenance transactions, or approximately 4.3 actions per ship operating year. This average ranks fourth highest among Launching System components.

With respect to Ship's Force man-hours expended, the Test Set ranks sixth with 130 man-hours reported, or an expenditure of 2.4 man-hours per

ship operating year. This is not considered a significant man-hour burden.

With reference to Table 3-1, the Test Set ranks fifth among Launching System components in the number of replacement parts required -- 107, or 1.8 replacements per ship operating year. Table 3-2 reveals that this action predominantly involves complete Test Set replacement, since 21 of 28 FF-1052 Launching Systems reported a total of 84 Test Set turn-ins. This situation is to be expected, since NAVSEA maintenance philosophy dictates a rotatable pool policy, with significant repairs and calibration accomplished by designated facilities. Normal calibration is required at 9-month intervals, which yield an average of 1.3 turn-ins per ship operating year, or 76 transactions based on a total of 58.5 ship operating years. Removing the known calibration requirements from the overall Test Set replacements results in 8 unexpected turn-ins of Test Sets over the 58.5 total-year interval. Performing the same reduction with respect to total part replacements (107) results in 31 unexpected replacements over the 58.5 operating years, or approximately 0.5 per ship operating year. This replacement rate does not in itself reflect a serious maintenance burden.

As indicated in Table 3-1, the total cost for Test Set MK 509 is in error. MDCS data indicate a total cost of about $1 million, but the full cost of the Test Set ($13,260) has repeatedly been charged when a set has been turned in and replaced. The result is an inaccurate representation of the actual cost to the Navy, since the turned-in set is almost always repaired at far less than the total cost, placed back in ready-for-issue status, and made available on the next demand.

CASREPT data, summarized in Table 3-3, reveal that the Test Set has been the subject of 5 reports, the highest number for Launching System components. This figure represents about one-fifth of all Launching System CASREPTs submitted over the 4-year reporting interval. Two CASREPTs reported lack of calibration as the primary cause of unsatisfactory operation; the other three CASREPTs did not reveal a specific cause of failure.

Surveys of three FF-1052 Class ships yielded a consensus that the Test Set is a problem area. Personnel of one ship stated that the Test Set is the most significant problem area in the Launching System, citing design deficiencies and supply delay problems as the principal causes. It is doubtful, however, that design weakness is the primary problem. Table 3-4 displays the maintenance transactions associated with the MK 509 Test Set for the 11 hulls in which Launching Systems were installed in 1971 and 1972. Considerable variance in maintenance burden is evident. The data accumulated over an average of 13 ship operating quarters indicate as few as 1 labor action of FF-1075 and FF-1078, and as many as 10 labor actions on FF-1072. This comparison indicates that design may not be primarily responsible for the relatively high maintenance-burden indicators previously discussed.

Table 3-4. TEST SET MK 509 TRANSACTIONS BY HULL NUMBER (Derived from MDCS Data over the period Jan 1970-Dec 1974)											
Quarter After Installation	Quantity of MK 509 Transactions for Indicated Hull										
	1062	1064	1066	1067	1071	1072	1074	1075	1077	1078	1079
1	1		1		1	1					
2		1	1						1		
3					1						
4							1		1		
5		1									
6						1					
7							2				
8						1			1		1
9		1	1			1			1		
10			1		1		1				
11			1	1	1	2				1	2
12		1		1	3	1		1	1		
13						2					
14	1										
15						1					
TOTALS	2	4	5	2	7	10	4	1	5	1	3

The analysis suggests that the Test Set suffers from the generic problems exhibited by most portable test equipments, e.g., unnecessary abuse during operation and damage in-transit -- both on board and to and from refurbishment sites. Further, the variance in total labor actions exhibited by the 11 FF-1052 Class ships selected for the analysis indicates the probability that expertise and conscientiousness of individuals charged with operation, repair, and transportation have a great influence on the reliability and required corrective maintenance of test equipment.

3.1.4.2 Test Set MK 509 Accessory/Rail Adaptor Junction Box Bracket Assembly

One Test Set MK 509 accessory deserving of particular mention is the rail adaptor bracket. Two of three ships surveyed indicated that this bracket is often damaged during Daily System Operational Test (DSOT) due to Launcher rail movement. All three ships reported difficulty in attaching the bracket to the rail. ORDALT 8301 has been initiated to provide an improved rail adaptor for the Test Set; however, as of July 1976, this ORDALT had only been implemented on one ship (FF-1078), and its effectiveness is unknown. Continued monitoring should be directed toward ascertaining the status of installation and success of this alteration.

MDCS data tend to verify the opinions of the ships surveyed. Table 3-2 identifies the MK 509 accessories as items with relatively high replacement rates. Eleven FF-1052 Class ships reported a total of 12 part replacements over the data period, an average of 0.2 per ship per operating year. This rate in itself would not appear to be a cause for concern. However, the replacement rate may not fully reflect the true situation aboard ship, since it is conceivable that the accessories might often be repaired or refurbished rather than replaced when damaged.

3.1.5 Loader MK 13

Loader MK 13 is a portable metal ladder structure. The ship surveys conducted during this analysis yielded the consensus that the Loader is unsafe due to instability. Analysis of 3-M "Detailed Record of Completed and Outstanding Repair/Alteration Actions" recorded over the total ship operating years indicated 8 total reports compiled on 6 ships concerning the safety of the Loader. Personnel have been injured, and the problem seems serious enough to warrant remedial action. Table 3-3 indicates that the Loader was also the subject of a CASREPT on one occasion.

ORDALT 8587, recently implemented on the FF-1052 Class during 1975 and 1976, is designed to improve the stability of the Loader. Unfortunately, because of the relatively short period of use since installation, the effectiveness of this ORDALT is unknown. Because of personnel safety considerations, we recommend that follow-up action be initiated to assess the effectiveness of ORDALT 8587.

3.1.6 Other MK 25 Launching System Components

Other components of the Launching System illustrated in Figure A-1 of Appendix A include:

a. Power Supplies MK 143 (2 per Launching System)

b. Motor Generator MK 6

c. Amplifier MK 40

d. Control Panel MK 65

e. Launcher area safety switch

f. Handling equipment

g. Hand Truck MK 42

h. Hydraulic pump

i. Tools

j. Missile Container MK 470

With the exception of the Amplifier MK 40, no abnormal maintenance burdens were evident in the MDCS data (see Tables 3-1 and 3-2) on the above-listed Launching System components. CASREPT data, summarized in Table 3-3, did cite defective relays as the cause of failure within the Control Panel on 3 occasions. In 2 of the 3 reports, the inoperative item was identified as Brake Control Relay CR5. One additional CASREPT was undefined, making a total of 4 reports against the Control Panel. This is a relatively high number of CASREPTs in relation to other Launching System components; however, the combined MDCS data do not indicate any specific recurrent part replacements in the Control Panel. No corrective action is considered warranted.

Amplifier MK 40, which ranked reasonably high in the MDCS analysis, was not verified as a problem by the ship surveys or by additional data analysis. The high-usage parts within the Amplifier, identified in Table 3-2, are 2 tubes (P/Ns 480269PC24 and 480269PC7). On the basis of 58.5 total ship operating years, the failure rates of these tubes are, respectively, 1.8 and 0.7 per ship operating year. These rates are considered within the expected range of tube design and not abnormally high. It is probable that a change to a transistorized design or improved cooling of the module would improve the situation, but the problem is not severe enough to warrant this expense. The rate of maintenance resource expenditure for the Amplifier is not increased by the implementation of DDEOC concepts and remains well within the capability of ships. Substantiation of this conclusion is found in Table 3-3, which indicates that no CASREPTs have cited MK 40 tube failures as the cause for reporting.

No abnormally high maintenance burdens were revealed by the analysis of the Launching System components listed above. Accordingly, no further investigation is considered necessary.

3.1.7 Component Summary

For all components identified in Table 3-1 as having had a reported maintenance burden over the data period, Table 3-5 summarizes the component analysis and resultant findings.

Table 3-5. LAUNCHING SYSTEM COMPONENT ANALYSIS SUMMARY

Component	Part	Problem Description
Guide MK 9	Band assembly	Galvanic corrosion
	Hydraulic coupling (incl. dust cap)	Corrosion
	Cell thermometer	Corrosion
	Arming access cover pin	Corrosion
	Safe/fire switch	Corrosion
Carriage MK 11	Sensitive switch	Corrosion
	120-wire connection box	Corrosion
	Waveguide mounting bracket	Corrosion
	Manual train mechanism	Corrosion
	Stand	Corrosion
	Lower carriage	Corrosion
Launcher Control Panel MK 288	Cell module Tuning drive	Relatively high operational failure of tuning drive within cell module. Corrective action is often replacement of entire cell module, not cost-effective.
Test Set and Accessories MK 509	Test Set	High operational usage, supply delays, ineffective repair and calibration.
	Accessory (rail adaptor junction box bracket)	Incompatibility of accessory with Launcher rail, repeated damage. ORDALT authorized but not completely implemented.
Loader MK 13	Not applicable	Instability causing hazardous loading operations. ORDALT implemented on all FF-1052 Launching System installations to improve Loader; however, effectiveness needs to be verified.

3.2 SYSTEM ANALYSIS

Analysis of the overall Launching System addressed several areas wherein the problems identified during the component analysis were interrelated. These areas, discussed below, include logistics support (Section 3.2.1), existing improvement programs (3.2.2), future development programs (3.2.3), Class A turnaround overhaul (3.2.4), the general corrosion problem (3.2.5), Launcher wearout trends (3.2.6), and material condition assessment (3.2.7).

3.2.1 Logistics Support

The Launching System is essentially of a modular design, and therefore its components are often not repairable by Ship's Force. These components are repaired by Navy industrial facilities and reinserted into the supply system. Therefore, logistics planning is essential to the orderly support of Launcher elements.

A unique situation exists with Test Set MK 509. The Test Set is a rotatable pool item and is periodically returned to a weapon station for calibration and repair. The peculiarity of this situation is that MDCS data indicate that on each Test Set turn-in, its full purchase cost of $13,260 is charged. Calibration and repair of the MK 509 Test Set is at no cost to the ship; therefore, no billing should occur.

Ships' personnel commented that the module turn-in program suffers from slow response. The experience of one ship surveyed is that a delay of 3 months is typical for receipt of replacement modules. This situation can intensify the maintenance problems for high-replacement modules because of subsequent failures that occur before failed modules have been replaced in onboard spares.

Ship surveys also indicated difficulty in obtaining Guide MK 9 thermometers. A message from NSWSES has authorized a reduction in the number of thermometers required from eight (one per missile cell) to four (one for each upper cell). The latest Fleet ORDALT Program Semi-Annual Status Report (July 1976) indicates that this message has resulted in the authorization of ORDALT 8850, which formally approves the reduction in quantity required. This reduction should alleviate the supply problem by lowering the Fleet population of this item by 50 percent. Improved preventive maintenance directed toward reducing corrosion damage would also help. It is evident that a supply shortage has existed for this item (P/N 2856857, NSN 4318717); however, implementation of ORDALT 8850, combined with improved corrosion control, should provide an adequate solution.

The Launching System will be maintained and supported by more than one depot-level activity. Shipyard facilities are fully capable of performing basic refurbishment of the Launcher during Baseline Overhaul and Selected Restricted Availabilities. NAVSEA will provide the major overhaul capability, utilizing NOS, Louisville, as the designated site for the

Launcher Class A Turnaround Overhaul. Other NAVSEA field activities, such as Naval Sea Centers and Naval Weapon Stations, provide repair and calibration facilities for various Launcher components and Test Sets, and for ORDALT installation. The ordnance branches of NAVSEA should be closely associated with the development and upgrading of procedures such as POT&I, DSOT, and any other preoverhaul-type tests.

3.2.2 Existing Improvement Programs

During the past 5 years, considerable ORDALT activity has been directed toward the Launching System. As of the July 1976 ORDALT Status Report, more than 90 percent of these ORDALTs have been implemented; and those not completed can be accomplished prior to or during Baseline Overhaul. Since none requires more than a 3-week period for accomplishment, most can be installed under the supervision of NAVSEACEN personnel during routine inport periods, if planned for in advance.

ORDALTs that specifically address Launcher problem areas identified by the analysis are listed in Table 3-6. In most cases they have been accomplished, but so recently that insufficient data exist to evaluate their effectiveness. Therefore, continued monitoring is necessary for the components the ORDALTs were designed to improve.

Table 3-6. FF-1052 CLASS LAUNCHING SYSTEM ORDALTS

Problem Area	ORDALT	Explanation/Status
Launcher Control Panel MK 288	7986	Adds tuning drive module to APL. ORDALT accomplished on all 28 FF-1052 Class ships as of 1 July 1976 Status Report.
Loader MK 13	8587	Improves platform stability. ORDALT accomplished on all 28 FF-1052 Class ships as of 1 July 1976 Status Report.
Accessory MK 509	8301	Provides rail adaptor. ORDALT accomplished on 1 of 28 FF-1052 Class ships as of 1 July 1976 Status Report.
Guide MK 9	8850	Reduces the number of required cell thermometers. Can be immediately implemented as of 1 July 1976 Status Report due to nature of action. All that is required is formal authorization to reduce the quantity required; no labor action is involved.

3.2.3 Future Development Program

Discussions with PMS 404, the cognizant agency for future development of the Basic Point Defense Surface Missile System, reveal that the Fire Control System MK 115 on FF-1052 Class ships is scheduled for replacement during FY 78 or FY 79 by a dual-channel Fire Control System (FCS) MK 91. The MK 91 is currently installed on aircraft carriers. The Navy plans to remove these systems from the carriers and make them available for selected reinstallation on FF-1052 Class ships.

Replacement of FCS MK 115 will require modifications to the Launching System. However, technical discussions with NSWSES reveals that the Launcher changes are minor and can be accomplished by ORDALT with normally available resources in less than 3 calendar weeks. Therefore, no adverse impact on DDEOC is envisioned. The proposed change can easily be accomplished during scheduled SRA periods, and probably during normal in-port periods or Tender Availabilities.

3.2.4 Class A Turnaround Overhaul

NSWSES has estimated that no major overhaul will be required on the Launching System until approximately 10 to 12 years after system installation. At that time, it is anticipated that the Launcher will be removed and replaced with a new or refurbished one. The old Launcher will be delivered to NOS, Louisville for Class A Turnaround. Upon completion of overhaul, the Launcher will be available for installation on the next ship requiring Class A Overhaul of the Launcher.

If there is adequate planning to ensure that ships which first received the Launching Systems are also assured of receiving the first turnarounds, there will be no adverse impact on DDEOC. FF's 1062, 1064, 1067, 1071, 1072, 1075, and 1077 received installations in 1971. Therefore, assuming a 10-year required turnaround, these ships should be scheduled for Launcher replacement at the completion of the first DDEOC. Remaining ships of the 1052 Class will require Class A Turnaround on the Launching System during the second cycle. Considerable planning will be required to accomplish required Launcher turnaround during the second cycle because of the limited dollar and manpower resources available during SRAs.

Material Condition Assessment criteria and the procedures required to implement associated tests and inspections should be developed. This development is required to provide early determination of when Class A Turnarounds should occur on individual Launching Systems. NSWSES should be provided with the MCA results to permit early identification of the approaching need for overhaul, thereby providing sufficient lead time for coordination of support resources.

3.2.5 Corrosion-PMS Evaluation

As indicated by the tendency for more than one component within the Launching System to exhibit evidence of corrosion, it can be considered an

overall Launcher problem. In Sections 3.1.2 and 3.1.3, corrosion problems were discussed for the Launcher Guide and Carriage, respectively. The primary solution to the corrosion problems will be to improve PMS procedures applied to the Launching System. A review of MRCs applicable to the Launching System is documented in Appendix B (DDEOC MRC Evaluation). As indicated therein by the minor changes recommended on the basis of the MRC review, the existing PMS is considered adequate. All three ships included in the surveys evaluated the PMS as being adequate in meeting the maintenance requirements of the Launching System. Review of the personnel and manning requirements revealed that all ships were allowed two Fire Control Technicians (FTs) and two Gunners Mates (GMs) with appropriate NEC codes to maintain the Launching System. Two of the three ships surveyed were at a 100-percent manning level, and the third was manned at 75 percent with one billet temporarily unfilled.

Overall evaluation of the PMS and allocated manning indicates that both are satisfactory. However, the repeated evidence of corrosion problems revealed by the relatively high MDCS reported maintenance burden on Guide MK 9 and Carriage MK 11, and by the statements of personnel from all three ships surveyed concerning corrosion problems, suggest that improvement is desirable. Increased emphasis on corrosion control through revised MRCs, and additional motivation of personnel assigned to perform preventive maintenance, should provide adequate improvement.

3.2.6 <u>Trend Analysis</u>

In an effort to identify significantly increasing maintenance requirements with respect to elapsed time since installation, the eleven FF-1052 Class hulls that had received the earliest Launching System installations (1971-1972) were identified. The maintenance data reported by these hulls for the six highest-ranking maintenance-burden components of the system were then aggregated and normalized by quarter after Launching System installation date. This process permitted the display of key maintenance parameters indicative of experienced maintenance burden over time.

The hull numbers of the eleven FF-1052 Class ships having the earliest Launching System installation dates and the six Launching System components addressed in this analysis are identified as follows:

Hull Numbers

1062	1074
1064	1075
1066	1077
1067	1078
1071	1079
1072	

<u>Launcher Component/APL</u>

Guide MK 9/006220002 and 006220066

Carriage MK 11/006220003

Launcher Control Panel MK 288/006220001 and 006220065

Test Set MK 509/006220008

Amplifier MK 40/006220004

Loader MK 13/006220063

The average ship and IMA man-hour data resulting from this process are tabulated in Table 3-7 and graphically displayed in Figures 3-1 and 3-2.

Table 3-7. AGGREGATE LAUNCHER COMPONENT AVERAGE BURDEN

Quarter	Ship Man-Hours	IMA Man-Hours
1	8.745	4.773
2	4.273	7.909
3	12.327	0
4	8.246	0
5	12.018	0.091
6	4.063	0
7	7.390	0
8	17.719	0
9	13.245	1.909
10	14.900	2.382
11	12.062	2.636
12	7.836	2.551
13	8.562	2.516

Figure 3-1 is a plot of the average IMA man-hours reported per ship per quarter after Launching System installation. The data points for quarters 1 and 2 are inconsistent with the remaining 11 quarters. This is attributed to maintenance problems associated with initial system installation. The remaining data points do reflect a maintenance burden between 0 and 2.6 man-hours per quarter, with the mean or average burden through 13 quarters being 1.9 man-hours per quarter. This is not considered a significant burden, and there is not sufficient evidence to conclude that the IMA maintenance burden will become significant during an extended operating cycle.

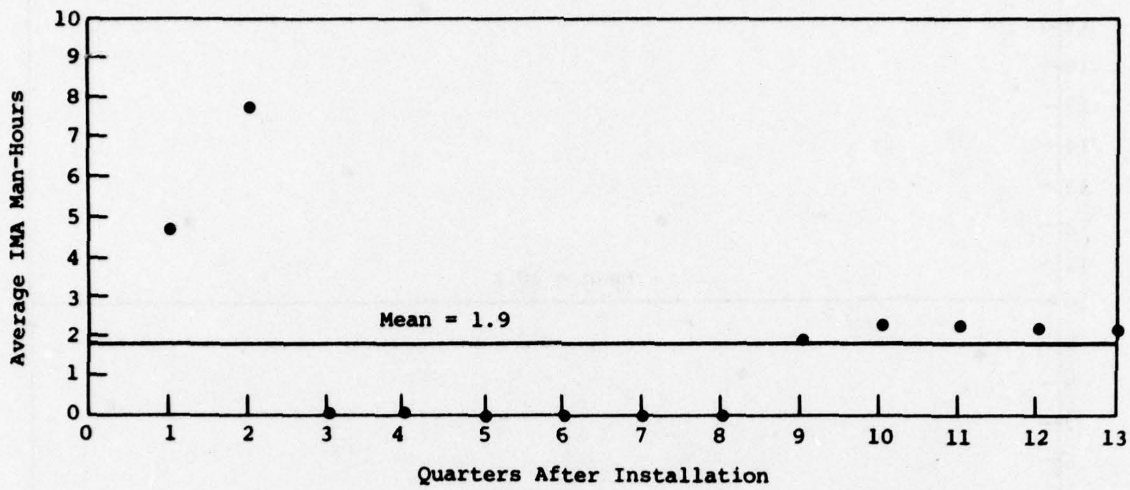


Figure 3-1. AGGREGATE LAUNCHER COMPONENT AVERAGE IMA MAN-HOURS VS QUARTERS AFTER INSTALLATION

Figure 3-2 is a plot of the average Ship's Force man-hours reported per ship per quarter after Launching System installation. The data points are a random scattering and do not indicate any discernible trend with time. The mean Ship's Force maintenance burden per quarter through 13 quarters is 10.1 man-hours, with a maximum quarterly average of 17.7 man-hours occurring in the eighth quarter. Neither the mean nor the maximum man-hour levels are considered significant quarterly burdens.

On the basis of these analyses, no significantly increasing maintenance trends during the extended operating cycle are anticipated.

3.2.7 Material Condition Assessment

Due to the uncertainty of anticipating when the Launching System will require major overhaul, it is recommended that tests and inspections be developed that will provide an indication of the approaching need for overhaul. The estimate that the Launcher will require Class A overhaul in approximately 10 to 12 years is not contradicted by available Launcher data, but neither is it substantiated. As indicated by the Launching System installation dates listed in Table A-2, the Launcher has not operated long enough to provide data indicating overhaul frequency.

The recommended tests and inspections should be designed to provide an independent assessment of the severity of corrosion conditions on the Launcher. The corrosion problems discussed are a major concern to DDEOC. Table 3-5 illustrates the variety of components and parts exhibiting

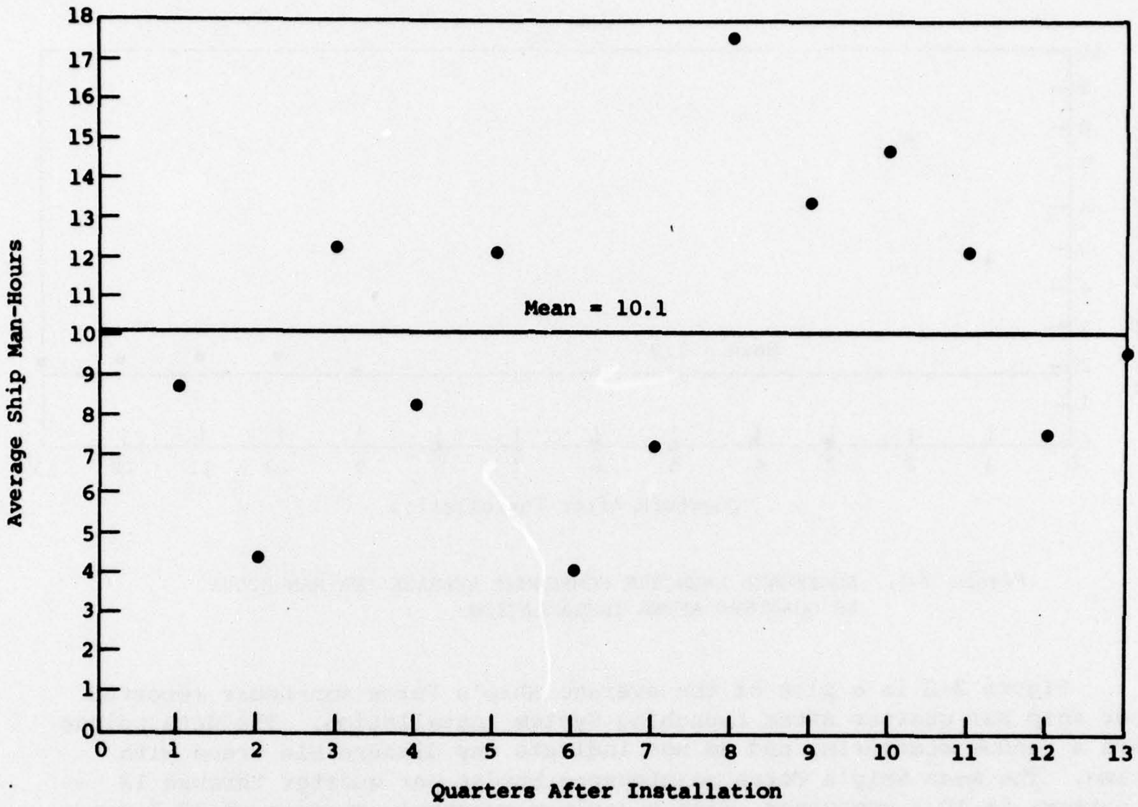


Figure 3-2. **AGGREGATE LAUNCHER COMPONENT AVERAGE SHIP MAN-HOURS VS QUARTER AFTER INSTALLATION**

corrosive tendencies. Part of the corrosion problem can be attributed to neglect by personnel to refurbish corroded components early enough to prevent serious damage. An independent assessment of Launcher condition by IMA or DDEOC site teams prior to SRAs could identify individual hulls on which the Launcher is in need of refurbishment and maintenance. This information could then be inserted into the SRA planning cycle.

CHAPTER FOUR

CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

The most significant conclusion from the analysis of the Basic Point Defense Surface Missile Launching System is that the system, with proper planning and scheduling, can effectively perform its intended mission within the revised operational scenario defined by DDEOC. Maintenance actions resulting from the System Maintenance Analysis are compatible with DDEOC.

The operational availability of the Launching System can be expected to increase if the SMA recommendations are implemented. No major design change is involved in the recommended Launcher improvements. The most significant recommendations involve improvement of the operational and support procedures for Test Set MK 509, and increased emphasis on effective corrosion control for the Launcher structure through more diligent inspection and PMS.

This Review of Experience for the Launching System has identified the need for developing performance and material condition criteria, and performance testing, material inspection, and monitoring procedures. These criteria and procedures would identify and define added requirements for Planned Maintenance, POT&I, DDEOC Site Team test and inspection, and Material Condition Assessment for establishing the need for Class A Overhaul.

From the analysis it is concluded that major overhaul of the Launching System will not be required during the Baseline Overhaul. Planning should be carried out for a Class A Turnaround Overhaul of the Launching Systems installed in 1971-1972 during the ROH following the first extended operating cycle. The degree of degradation of Launching Systems on individual ships will vary; therefore, the final decision on whether a specific ship requires a Class A Turnaround Overhaul of its Launching System should be a function of an inspection of the type discussed in Section 3.2.7. For those FF-1052 Class ships that received Launching System installations in 1973 and later, it is anticipated that Class A Turnaround Overhaul of the Launching System will be required at some time during the second extended operating cycle. As with the earlier installations, the final

decision for an individual ship's installation should be based on a Launching System material condition inspection. The results of this inspection will permit planning for necessary Launching System Class A Turnaround Overhauls during selected restricted availabilities of the second extended operating cycle.

4.2 RECOMMENDATIONS

Proposed corrective actions and required planning determined from the Launching System analysis are categorized as follows:

a. Reliability and Maintainability Improvements (Section 4.2.1)

b. Planned Maintenance Subsystem Changes (Section 4.2.2)

c. Baseline Overhaul Requirements (Section 4.2.3)

d. Integrated Logistics Support Improvements (Section 4.2.4)

Explanation in the form of supporting information and analysis summaries is provided with the recommendations. Where appropriate, references to sections within this report containing more detailed analysis are included. Appendix C (DDEOC Action Table) identifies agencies responsible for the implementation of the recommended actions, and suggests means for monitoring their accomplishment.

4.2.1 Reliability and Maintainability Improvements

4.2.1.1 Test Set MK 509 Accessory/Rail Adaptor Junction Box Bracket Assembly

Recommendation

As rapidly as scheduling and funding allow, implement ORDALT 8301, which provides an improved rail adaptor for Test Set MK 509. Evaluate the effectiveness of this ORDALT in improving the compatibility of the adaptor with Launcher Rail MK 128 MOD 1.

Problem

During ship surveys of FF-1052 Class ships, two of three ships visited reported damage to the rail adaptor when Launcher rail movement was experienced. The rail adaptor is also difficult to connect to the rail during DSOT, and personnel from all three ships surveyed stated that the adaptor has been damaged during that process.

Explanation

ORDALT 8301 provides an improved rail adaptor for the Test Set, which is designed to enhance rail-to-adaptor compatibility. Rapid accomplishment of this alteration on all remaining FF-1052 Launching System installations

is desirable prior to or during BOH to bring all Launchers to the most current and reliable configuration prior to EOC. Increased operational availability is probable since the ORDALT should reduce incidences of inadvertent damage to the rail adaptor. As of July 1976, this ORDALT had been implemented only on the FF-1078. Therefore, insufficient data exist to evaluate the effectiveness of the ORDALT in eliminating the problems associated with rail-to-adaptor compatibility.

4.2.1.2 Guide Band Assembly MK 9

Recommendation

Investigate the feasibility of using the same noncorrosive material for both the Guide Band and the retaining/adjusting bolts. If feasible, initiate an ORDALT implementing a material change.

Problem

Galvanic corrosion is common between the Guide Band and the retaining/adjusting bolts.

Explanation

MDCS data analysis revealed that the Guide Band Assembly was replaced a total of 12 times on four ships at a total cost of $1,800. Surveys of all three ships visited in this study revealed that galvanic corrosion between the Band and its retaining/adjusting bolts had been experienced. Ship personnel indicated that increased lubrication was ineffective in preventing this condition. The problem is not a major one, since complete replacement of the Band and associated fasteners costs approximately $150 and Ship's Force is capable of performing the action. Inspection, through conscientious performance of the present PMS, should detect a potential problem prior to catastrophic failure. The condition is undesirable, however, and investigation appears warranted to determine if the design specifications permit the use of a noncorrosive material.

4.2.1.3 Loader MK 13

Recommendation

ORDALT 08587 (Stability Improvement) for the MK 13 MODS 0 and 1 Loader has been accomplished on all FF-1052 Class ships. The effectiveness of this ORDALT in eliminating the original safety hazards should be assessed.

Problem

Historical data indicate that the Loader is unstable and considered a personnel safety hazard in its original configuration.

Explanation

Three ships surveyed indicated unanimous concern over the personnel safety aspects of the MK 13 Loader. The "Detailed Record of Completed and Outstanding Repair/Alteration Actions" during the reporting period January 1970 to December 1974 cites eight instances of possible accidents during the use of the Loader. Six ships reported the problem, five of which had ORDALT 08587 installed prior to 1 July 1975. Unfortunately, the exact dates of ORDALT installation are unknown and therefore the effectiveness of the ORDALTs cannot be determined from available data. July 1976 ORDALT Status Reports indicate complete accomplishment of the ORDALT on all 28 FF-1052 Basic Point Defense installations. Therefore, sufficient experience should now have been accumulated to verify the effectiveness of the alteration. In view of the past severity of the problem, an immediate survey of all ships is recommended to assess the degree of safety improvement.

4.2.2 PMS Changes for Launching System

Recommendation

MRCs should be developed to provide definitive corrosion control PMS requirements for specific Launcher components. As a minimum, the revised requirements should change the Launching System MIP 5AEB000/2-6 M-1 (SYSCOM MRC Control No. 75 CNNE M1) to include inspection and refurbishment procedures directed toward the control of corrosion on the following components:

a. Guide Assembly MK 9 -- Inspect thermometers, band assembly, hydraulic coupling, arming access cover spring pins, and the safe/fire switch.

b. Carriage MK 11 -- Inspect sensitive switch, 120-wire connection box, waveguide mounting brackets, manual train mechanism, stand, and lower Carriage.

It is further recommended that Fleet units emphasize the requirement that preventive maintenance is to be performed as scheduled.

Problem

Severe corrosion has been experienced in the Launcher Guide and Carriage.

Explanation

All three ships surveyed indicated that corrosion of the Carriage and Guide is a problem severe enough to represent the limiting factor to an extended operating cycle. MDCS data indicate that high maintenance burdens have been experienced on the Launcher Guide and Carriage Assemblies. The Guide has been involved in 517 maintenance transactions totalling 708 ship

man-hours at a repair cost of approximately $78,000. The Carriage has had 423 maintenance transactions, 1,217 ship maintenance man-hours, and a repair cost of $20,000. Both the maintenance transaction and ship man-hour totals represent the highest experienced by Launching System components. Failures of the Guide and Carriage have been predominantly due to corrosion. Ship personnel and cognizant technical managers are unanimous in the opinion that corrosion is a serious problem in the Guide and Carriage.

4.2.3 Baseline Overhaul Requirements

No specific major maintenance actions for the Launching System during Baseline Overhaul were identified in this Review of Experience. Neither did a trend analysis of MDCS data indicate significant degradation with respect to time for any Launcher components. However, the MDCS data did reflect relatively high maintenance activity directed toward corrosion control on Launcher components. Personnel of the three ships surveyed confirmed that corrosion is a serious problem of the Launching System. The most probable need for maintenance of the Launcher during BOH will be for refurbishment or replacement of corroded Launcher components.

It is recommended that inspection procedures be developed that are tailored to uncover Launcher deficiencies due to corrosion and to assess accurately the material condition of the Launcher. The POT&I should incorporate test and inspection procedures specifically directed toward identifying corrosion damage in the following components:

a. Guide Assembly MK 9 -- Thermometers, band assembly, hydraulic coupling, arming access cover spring pins, and the safe/fire switch.

b. Carriage MK 11 -- Sensitive switches, 120-wire connection box, waveguide mounting brackets, manual train mechanism, stand, and lower Carriage.

4.2.4 ILS Improvement, Test Set MK 509

Recommendation

It is recommended that NSWSES initiate a detailed study of the MK 509 Test Set support program and operational usage. The study should be specifically directed to determining the reasons for receipt of improperly repaired and calibrated Test Sets, the lengthy repair and calibration turnaround time, and the reported inadequate supply of Ready-for-Issue Test Sets. On the basis of the results of this study, an improvement program should be developed to increase the operational availability of the MK 509 Test Set.

Problem

Ineffective repair and calibration, lengthy repair turnaround, inadequate supply quantity, poor operational availability, and funding problems.

Explanation

Analysis of MDCS data over a 5-year interval indicates the Test Set has been involved in 247 maintenance actions at a reported total maintenance cost of approximately $1 million. This represents the fourth highest maintenance transaction total and highest repair cost of all Launcher components. The cost is not considered a valid figure because of the billing procedure which is reflected in the data (see Section 3.1.4.1 and 3.2.1).

Surveys of three FF-1052 Class ships identified the Test Set as a serious maintenance problem area; personnel of one ship considered it the most significant maintenance problem within the Launching System. Ship personnel state that the Test Set is a high-usage equipment with a high ambient temperature and limited duty cycle. Design tolerances are tight, and relatively high failure rate is experienced. Thus, rapid repair and turnaround are essential. Personnel of all ships surveyed complained of excessive repair turnaround time, and receipt of improperly functioning or inoperative Test Sets from the rework facility. CASREPT data indicate that the Test Set has been cited on five occasions, representing about one-fifth of all Launcher CASREPTs over a 4-year reporting interval.

Calibration of the Test Set is required at 9-month intervals. With this requirement, an inherent turnaround of significant magnitude will always occur, and it is thus imperative that the ILS program for the Test Set be efficient and responsive. The lack of a properly functioning support program is indicated by the MDCS data for the Test Set, which suggest that calibration is not being performed in accordance with the required schedule, and turnaround time is highly erratic.

Data obtained in the analysis of 11 early-installation (1971-1972) Launchers indicate considerable ship-to-ship variance in required turnaround over the average 13-quarter reporting interval. Two ships indicate as few as one required labor action, and two other ships report only two such transactions. At the opposite extreme was one ship needing 10 labor actions, and a second requiring seven actions. The remaining five ships within the analysis group were spread between three and five required actions. This high variation indicates that design is not the primary cause for the low operational availability of the Test Set. The causes of its problems are present operational procedures, personnel expertise, and deficiencies in rework capability, supply, and transportation and handling. In addition, NSWSES indicates that end-of-year funding problems are serious, a situation wherein calibration and repair actions are curtailed. Consequently, the availability of Ready For Issue (RFI) Test Sets is reduced and Fleet requirements are not fulfilled.

REFERENCES AND SOURCES OF INFORMATION

1. Allowance Parts Lists - (See Table A-1 for specific identification of APLs investigated).
2. Ordnance Publications - NAVORD OP 3973, Vols. 1-4.
3. MDCS Data, 1 January 1970-31 December 1974.
4. Type Commander COSAL, SURFLANT (May 1975) and SURFPAC (August 1975).
5. Casualty Reports, 1 January 1970-31 December 1974.
6. Planned Maintenance Subsystem (PMS) - MIPs/MRCs for FF-1063 (April 1975).
7. Ship Surveys - USS TRIPPE (FF-1075), USS BLAKELY (FF-1072), and USS MONTGOMERY (FF-1082), during the period 11-14 November 1975.
8. 3-M "Detailed Record of Completed and Outstanding Repair/Alteration Actions" - MSO.4790.S270A.A06, January 1970-December 1974.
9. Basic Point Defense Surface Missile System (BPDSMS) Fleet ORDALT Program Semi-Annual Status Report - July 1976.
10. Fleet Modernization Program Ordnance Improvement Plan, Fiscal Year 1977, as of 5 August 1975.
11. NAVSEACENLANT and COMNAVSURFLANT visits, 11-14 November 1975.
12. NAVSEA, Escort and Cruiser Ship Logistic Division FF-1052 Critical Equipment List.
13. Master Cross Reference List (MCRL).

APPENDIX A

SYSTEM BOUNDARIES, CONFIGURATION, AND APL LISTING

Figures A-1 and A-2 depict the boundaries of the MK 25 Guided Missile Launching System pictorially and by functional block diagram respectively. Table A-1 lists the FF-1052 Class hulls having the MK 25 Launching System and their respective dates of installation. Table A-2 lists the APL numbers for the components which comprise the MK 25 Launching System.

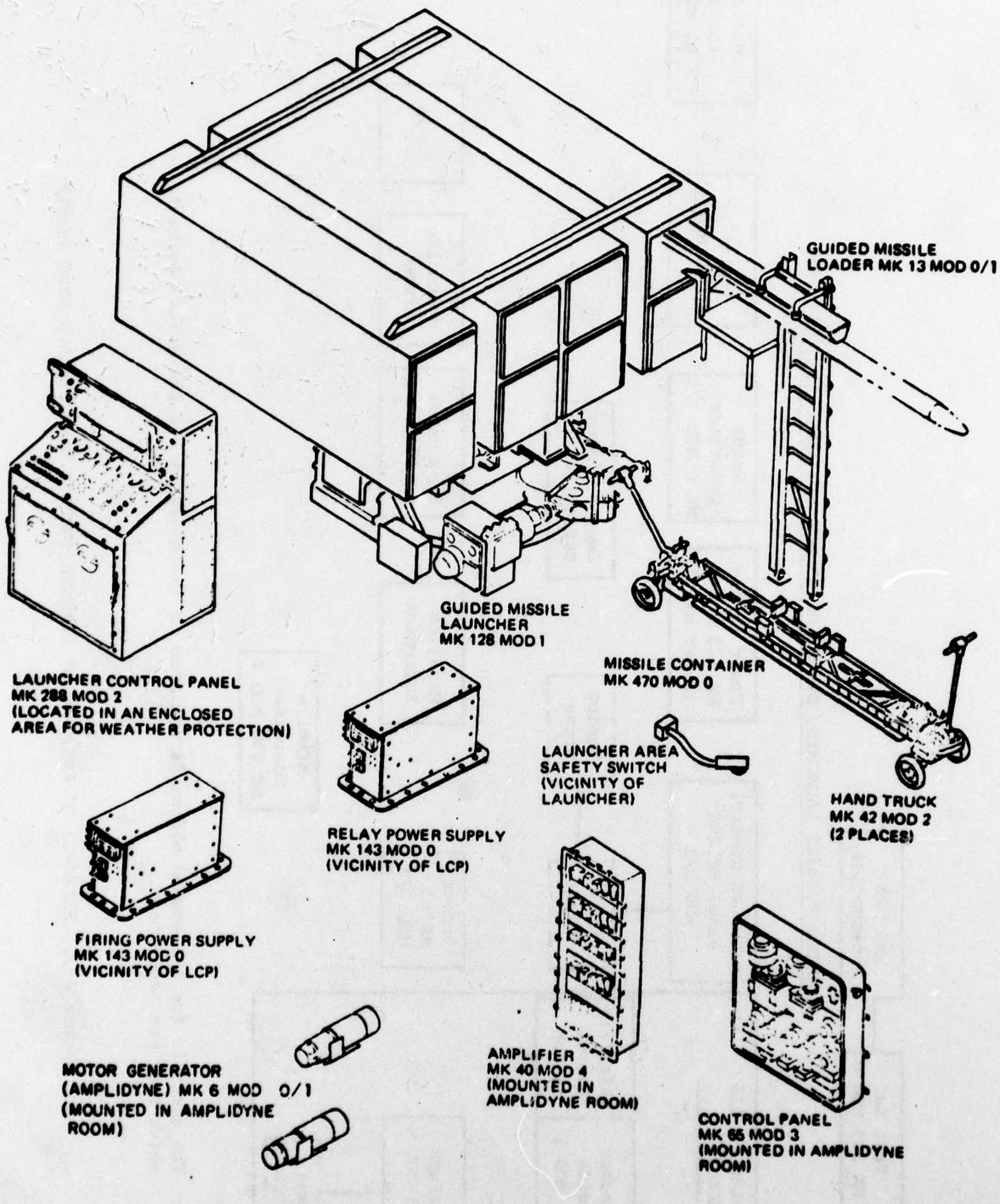
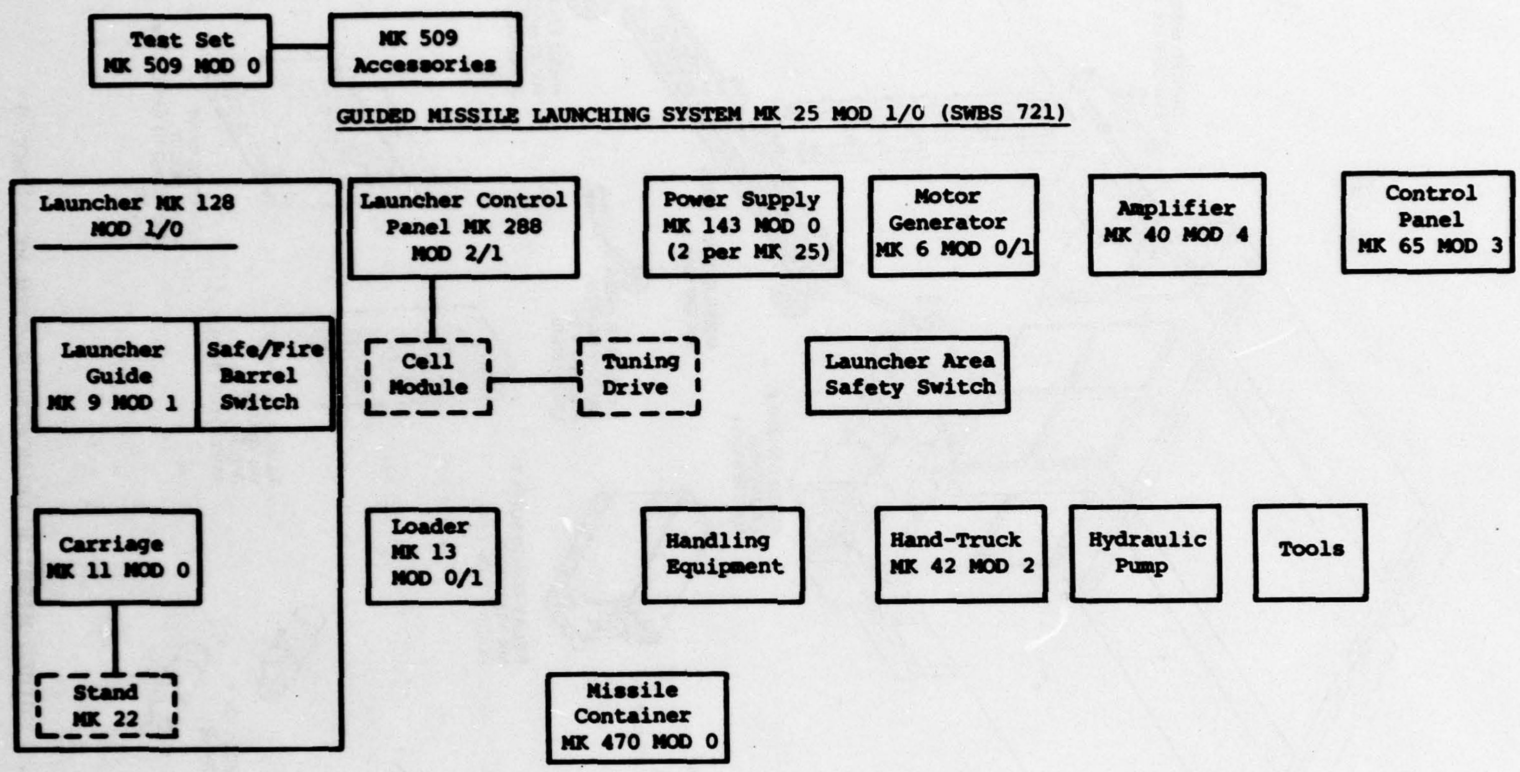


Figure A-1. GUIDED MISSILE LAUNCHING SYSTEM MK 25 MOD 1



NOTE: The analysis for the dashed blocks is included in the analysis for the solid blocks to which they are connected.

Figure A-2. ELEMENTS OF BASIC POINT DEFENSE SURFACE MISSILE LAUNCHING SYSTEM

Table A-1. COMPONENT APL IDENTIFICATION

Component	APL
Test Set MK 509 MOD 0 and Accessories	006220008 006220056
Launcher Guide MK 9 MODs 1/0	006220066 006220002
Carriage MK 11 MOD 0	006220003
Stand MK 22 MODs 2/3	006030001 006050001
LCP MK 288 MODs 2/1	006220065 006220001
Loader MK 13 MODs 0/1	006220063
Power Supply MK 143 MOD 0	006220007
Motor Generator MK 6 MODs 0/1	006220005
Amplifier MK 40 MOD 4	006220004
Control Panel MK 65 MOD 3	006220006
Handling Equipment	0-004920027
Hand Truck MK 42 MOD 2	005030008
Tools	006220001
Hydraulic Pump	006220013
Missile Container MK 470 MOD 0	No APL

Table A-2. FF-1052 LAUNCHING SYSTEM INSTALLATIONS

Hull Number	Installation Date (Calendar Year/Quarter)
1052	72/Fourth
1053	74/Fourth
1054	75/First
1055	73/Fourth
1056	74/Third
1057	74/Second
1058	74/Second
1059	73/Second
1060	74/First
1062	71/Third
1063	72/Third
1064	71/Third
1065	72/Fourth
1066	72/First
1067	71/Second
1071	71/Fourth
1072	71/Third
1073	75/First
1074	72/First
1075	71/Fourth
1076	72/Third
1077	71/Third
1078	72/First
1080	72/Third
1081	72/Third
1082	72/Third
1083	72/Fourth

APPENDIX B

DDEOC MRC EVALUATION

This appendix presents a tabulation of MIPs currently applicable to the BPDSMS Launching System (Table B-1). A copy of those MIPs listing MRCs for which changes are recommended (the Δ symbol denotes changed MRCs), and a DDEOC MRC Evaluation Table itemizing the recommended changes are also included. Column headings of that table are explained as follows:

- MRC Title - Description of maintenance specified by MRC
- MRC Number - Identification number of MRC
- Responsibility - Organizations responsible for change (if any)
- Current Status - (Self-explanatory)
- Man-Hours - Personnel time burden allotted to complete maintenance action
- Frequency - When the MRC maintenance action is to be performed. The periodicity codes used, such as D = Daily, are standard codes defined in the 3-M Manual, OPNAV Instruction 4790.4 series.
- Type - Perform maintenance (P), or survey material condition of component (S)
- Who Performs Test - Maintenance action or test to be performed by tender, DDEOC Field Site Team, or Ship's Force personnel
- Where Performed - (Self-explanatory)
- Data - Indicates whether data are recorded during performance of maintenance action

Table B-1. BPDSMS LAUNCHING SYSTEM MIPs

MIP Title	MIP Number	Effective Date
Basic Point Defense Surface Missile System	5WE1000/6-7	November 1975
Guided Missile Launching System, MK 25, MOD 1	5AEB000/2-6	July 1975
Guided Missile Launching System, MK 25, MOD 1	5AEB000/U5-5	July 1975
Sling, Container Lifting, MK 77, MOD 3	8-168/1-C1	December 1971
Cradle Storage MK 21, MOD 0	8-263/1-83	August 1973

SYSTEM, SUBSYSTEM, OR COMPONENT	REFERENCE PUBLICATIONS	DATE
Guided Missile Launching System Mk 25 Mod 1	NAVSEA OP 3973 (PMS/SMS)	July 1975

APPLICATION (THESE MAINTENANCE REQUIREMENTS ARE APPLICABLE TO EQUIPMENT IN WHICH THE FOLLOWING CHANGES HAVE BEEN ACCOMPLISHED)

ORDALTs: 6941, 6942, *6943, 6944, 6945, 6946, 6989, *7008, *7022, 7064, *7099, 7101, 7148, *7184, 7315, 7316, *7317, 7332, 7339, 7363, 7364, *7365, *7369, 7407, 7409, 7412, 7413, 7453, 7498, 7575, 7636, 7726, and 7883

***Denotes changes affecting maintenance procedures.**

SYSCOM MRC CONTROL NO.	MAINTENANCE REQUIREMENT	PERIODICITY CODE	SKILL LEVEL	MAN HOURS	RELATED MAINTENANCE
	MR Deleted.	D-1			
75 CNNC W	1. Lubricate launcher.	W-1	GMG3 GMGSN	1.0 1.0	None
T 75 CNND W	1. Test launcher operation in local mode.	W-2	GMG3 GMGSN	0.5 0.5	None
△ 75 CNNE M	1. Clean, inspect, and lubricate launcher.	M-1	GMG3 GMGSN	5.0 5.0	W-1
75 CNNF M	1. Inspect and clean Control Panel Mk 65 Mod 3.	M-2	GMG3	0.5	None
75 CNNG M	1. Inspect and clean Amplifier Mk 40 Mod 4.	M-3	GMG3	0.7	None
75 CNNH M	1. Inspect, clean, and lubricate Launcher Control Panel Mk 288 Mod 2.	M-4	GMG3	0.5	None
42 BXNV M	1. Lubricate Guided Missile Loader Mk 12 Mod 1. NOTE: This maintenance requirement is applicable on BPDSMS installations with Guided Missile Loader Mk 12 Mod 1 only.	M-5	GMG3	1.0	None
C4 CLXH M	1. Lubricate Guide Missile Loader Mk 13 Mod 0/1. 2. Lubricate Guided Missile Loader Mk 13 Mod 0/1 Deck Mount Baxter bolts. NOTE: This maintenance requirement is applicable on BPDSMS installations with Guided Missile Loader Mk 13 Mod 0/1 only.	M-6	GMG3	0.1	None
C4 CLXJ M	1. Clean, inspect and lubricate	M-7	GMGSN	1.0	None

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SYSCOM MRC CONTROL NO.	MAINTENANCE REQUIREMENT	PERIODICITY CODE	SKILL LEVEL	MAN HOURS	RELATED MAINTENANCE
C4 CLXK Q	**1. Inspect train and elevation receiver regulators and drive motors and remove accumulated condensation.**	**Q-1**	**GMGSN**	**0.5**	**None**
C4 CLXL Q	**1. Inspect launcher cable twist area below launcher.** **2. Lubricate launcher cable twist cables and train limit stop detent.**	**Q-2**	**GMG3** **GMGSN**	**2.0** **2.0**	**None**
C4 CLXM S	**1. Inspect carriage and lubricate elevation power-off brake hand release lever.**	**S-1**	**GMG3** **GMGSN**	**0.5** **0.5**	**M-1**
75 CNNJ S	**1. Clean, inspect, and lubricate train and elevation motor generators.**	**S-2**	**GMG3**	**0.7**	**None**
65 CMXC S	**1. Clean, inspect, and lubricate train and elevation drive motors.**	**S-3**	**GMG3**	**1.0**	**None**
23 CEXZ S	**1. Clean and inspect fire interrupter.**	**S-4**	**GMG3**	**1.0**	**M-1**
42 BXPB S	**1. Clean ventilation blower screens.**	**S-5**	**GMGSN**	**0.5**	**None**
C4 CLXN S	**1. Inspect cable entry boxes EP-12, 34, 56, 78 and remove accumulated moisture.** **2. Inspect 120 wire connection box EB-1 and remove accumulated moisture.**	**S-6**	**GMG3** **GMGSN**	**1.0** **1.0**	**None**
C4 CLXP S	**1. Test continuity of frangible cover anti-icing frame.** **2. Test operation of frangible cover anti-icing circuit.**	**S-7R**	**GMG3** **GMGSN**	**2.5** **2.5**	**S-6, S-8R**
C4 CLXQ S	**1. Test cell ventilation fan**	**S-8R**	**GMG3** **GMGSN**	**1.0** **1.0**	**S-6, S-7R**
14 CHVH A	**1. Inspect train and elevation receiver regulators.**	**A-1**	**GMG3** **GMGSN**	**2.0** **2.0**	**Q-1**
	MR Deleted.	**A-2**			
65 CMXD A	**1. Inspect, clean and lubricate limit switch MK 6 MOD 1 actuating plungers.**	**A-2R**	**GMG3**	**0.5**	**None**
75 CNNK C	**1. Lubricate fire-thru latch.**	**C-1**	**GMG3** **GMGSN**	**6.0** **6.0**	**None**

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SYSCOM MRC CONTROL NO.	MAINTENANCE REQUIREMENT	PERIODICITY CODE	SKILL LEVEL	MAN HOURS	RELATED MAINTENANCE
23 CEYC R	1. Inspect motor fire connector. NOTE: Perform after every unmating.	R-1	GMG3	0.5	None
23 CEYD R	1. Test fire-thru latch. NOTE: Perform prior to loading cell.	R-2	GMG3 GMGSN	0.5 0.5	None
65 CMXG R	1. Inspect motor fire connector. 2. Lubricate, clean and inspect launcher guide. NOTE: Perform after each firing.	R-3	GMG3 GMGSN	2.0 2.0	None
65 CMXE R	1. Lubricate launcher for cold weather operations. NOTE: Perform prior to entering area where temperatures below $0^{o}F$ are anticipated.	R-4	GMG3 GMGSN	1.0 1.0	None
65 CMXF R	1. Test plug-in type 115 VAC and 28 VDC relays. NOTE: Perform when plug-in type relays require testing.	R-5	GMG3	0.5	None
75 CNNL R	1. Load launcher using Loader Mk 12 Mod 1. 2. Unload launcher using Loader Mk 12 Mod 1. NOTE: Perform when launcher cells require loading or unloading.	R-6	GMG3 3GMGSN	1.0 3.0	None
75 CNNM R	1. Load launcher using Loader Mk 13 Mod 0 or 1. 2. Unload launcher using Loader Mk 13 Mod 0 or 1. NOTE: Perform when launcher cells require loading or unloading.	R-7	GMG3 3GMGSN	1.0 3.0	None
	INACTIVE EQUIPMENT MAINTENANCE				
	The following requirement will be scheduled when equipment is deactivated for periods of prolonged idleness. Lay-up Maintenance				
74 CLAS P	1. Perform Lay-up Maintenance. NOTE: This is a scheduling card. Schedule and perform listed MRCs for lay-up maintenance.	LU-1			

(Page 3 of 4)

SYSCOM MRC CONTROL NO.	MAINTENANCE REQUIREMENT	PERIO-DICITY CODE	SKILL LEVEL	MAN HOURS	RELATED MAINTE-NANCE
	<u>Periodic Maintenance</u>				
	1. Test launcher operation in local mode.				
	NOTE: Accomplish MRC W-2 monthly.				
	2. Lubricate launcher for cold weather operation.				
	NOTE: Accomplish MRC R-4 only if overhaul is performed in an area where temperatures of below $0^{O}F$ are anticipated.				
	<u>Start-up Maintenance</u>				
74 CLAT P	1. Perform start-up maintenance.	SU-1			
	NOTE: This is a scheduling card. Schedule and perform listed MRCs for start-up maintenance.				
	<u>Operational Tests</u>				
	1. Test launcher operation in local mode.				
	NOTE: Accomplish MRC W-2.				
	(Page 4 of 4)				

MAINTENANCE INDEX PAGE (MIP)
OPNAV FORM 4790-3 (C) (REV. 6-71)

SYSCOM MIP CONTROL NO. 5AEB000/2-6

DDEOC MRC EVALUATION

MRC TITLE	MRC NUMBER	RESPONSIBILITY		CURRENT STATUS			MAN-HOURS		FREQUENCY	
		NAVSEA	DDEOC	OLD WITH NO CHANGE	OLD WITH REVISION	NEW	PRE-DDEOC M/H	POST-DDEOC M/H	PRE-DDEOC	POST-DDEOC
1. Clean, inspect and lubricate launcher	75 CNNE M		X		X		10.0	To be Determined	M	M

*P = PERFORM MAINTENANCE; S = SURVEY INSPECTION

MRC EVALUATION

OURS	FREQUENCY		TYPE*	WHO PERFORMS TEST			WHERE PERFORMED	DATA	REMARKS
POST-DDEOC M/H	PRE-DDEOC	POST-DDEOC	P–PERF. S–SURV.	TENDER	DDEOC	SHIP	I–IN PORT S–AT SEA	YES NO	
To be Deter-mined	M	M	S,P			X	I,S	To be Deter-mined	MRC should be changed to include more stringent inspection to detect corrosion in various launcher components, and refurbishment instruction when required.

APPENDIX C

DDEOC ACTION TABLE

This appendix summarizes action information for each of the recommendations discussed in this report.

DDEOC ACTION TA

1. ACTION ITEM* a. NO.	b. TITLE	2. DDEOC EVALUATION**	3. ACTION ITEM DESCRIPTION	4. REPORT REFERENCE (PARA.)	5.
1.	MK 509 Accessory - Rail Adaptor Bracket		Complete implementation of ORDALT 8301. Verify effectiveness	3.1.4.2 4.2.1.1	
2.	MK 9 Guide Band Assembly - Galvanic Corrosion		Determine feasibility of utilizing the same non-corrosive material for both the band and the retaining/adjusting bolts. If determined feasible, develop ORDALT to implement improvement.	3.1.1 4.2.1.2	
3.	MK 13 Loader- Instability		Perform ship survey, evaluate ORDALT effectiveness in correcting safety hazard.	3.1.5 4.2.1.3	
4.	Launching System - Severe Corrosion		Revise MRC 75 CNNE M to include specific inspection and refurbishment (when required) procedures aimed at more effective corrosion control.	3.1.1 3.1.2 3.2.5 4.2.2	
5.	Launching System - Inspection and Test Procedures		The POT&I should be modified to include specific tests and inspections to determine overall material condition. A "Mini-POT&I" should be developed to allow a regularly scheduled quarterly independent assessment of launcher condition by an IMA or DDEOC site team.	3.2.4 3.2.7 4.2.3	
6.	MK-509 Test Set - ILS		Perform analysis of MK 509 operational procedures and support program. Improvement is indicated in operational usage, supply support, repair facilities, and transportation and handling procedures.	3.1.4 3.2.1 4.2.4	NS

* NOTE 1: DEVELOPING ACTIVITY FILL IN THE FOLLOWING BLOCKS: 1a, b; 3; 4; 5 (IF KNOWN); 6a, IF REQUIRED FOR CONTINUATIO

** NOTE 2: DDEOC EVALUATION – APPROVED, FURTHER STUDY REQ'D, ETC.

† NOTE 3: RESPONSIBILITY – NAVSEC, NAVSEA, NSRDC, ETC.

DEOC ACTION TABLE

	4. REPORT REFERENCE (PARA.)	5. RESPONSIBILITY †	6. SCHEDULING DATES a. REQD.	b. START	c. COMP.	7. REMARKS, FUNDING IMPLICATIONS, ETC.	8. ACTUAL ACTION TAKEN
.	3.1.4.2 4.2.1.1	NSWSES				Installed on one FF-1052 as of July 1976 data.	
p	3.1.1 4.2.1.2	NSWSES					
	3.1.5 4.2.1.3	NSWSES				Installed on all FF-1052 BPDSMS Systems as of July 1976 data.	
	3.1.1 3.1.2 3.2.5 4.2.2	NSWSES				Specific MRC revision requires development. Revision is required to increase emphasis on corrosion control.	
e	3.2.4 3.2.7 4.2.3					Specific material condition assessment criteria and the procedures required to implement associated tests and inspections require development. This development is required to provide early identification of the need for Class "A" overhaul.	
ve-	3.1.4 3.2.1 4.2.4	NSWSES					

ED FOR CONTINUATION OF DEVELOPING ACTIVITY TASK; 7, AS NECESSARY.